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INTERNATIONAL SEARCH REPORT

Int. Application No

PCT/EP 99/06952

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04L1/18 H04L1/00 H04L1/16 H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 841 526 A (WILSON JON C ET AL) 20 June 1989 (1989-06-20) abstract column 3, line 38 - column 4, line 56 column 8, line 11 - line 48 column 9, line 57 - column 10, line 22	1-9, 11-20
Y	EP 0 695 053 A (AT & T CORP) 31 January 1996 (1996-01-31) abstract column 1, line 10 - line 50 column 5, line 33 - column 6, line 11 column 8, line 4 - line 26 figure 3	1-9, 11-20
	-/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

12 July 2000

Date of mailing of the international search report

21/07/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax (+31-70) 340-2040

Authorized officer

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 99/06952

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>WO 98 20511 A (PACKETEER INC) 14 May 1998 (1998-05-14) abstract page 5, line 1 - line 23 page 6, line 5 - line 29 page 14, line 15 -page 16, line 13</p>	1,11
A	<p>US 4 939 731 A (REED ALLYSON ET AL) 3 July 1990 (1990-07-03) abstract column 1, line 43 - line 61 column 2, line 31 - line 56 column 4, line 47 -column 5, line 38</p>	1,11
A	<p>WO 96 36150 A (AHOPELTO JUHA PEKKA ;NOKIA TELECOMMUNICATIONS OY (FI); KANERVA MIK) 14 November 1996 (1996-11-14) abstract page 1, line 34 -page 2, line 15 page 4, line 30 -page 5, line 26 page 8, line 11 -page 10, line 8</p>	1,11

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. l. Application No

PCT/EP 99/06952

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4841526 A	20-06-1989	EP 0162478 A	27-11-1985
EP 0695053 A	31-01-1996	US 5570367 A	29-10-1996
		CA 2145782 A,C	29-01-1996
		CN 1123980 A	05-06-1996
		JP 8065355 A	08-03-1996
WO 9820511 A	14-05-1998	US 6038216 A	14-03-2000
		AU 5094498 A	29-05-1998
US 4939731 A	03-07-1990	AT 72080 T	15-02-1992
		AU 594216 B	01-03-1990
		AU 8234787 A	30-06-1988
		CA 1303678 A	16-06-1992
		DE 3776332 A	05-03-1992
		EP 0290525 A	17-11-1988
		WO 8804496 A	16-06-1988
		TR 23547 A	22-03-1990
WO 9636150 A	14-11-1996	FI 98023 B	13-12-1996
		AU 707904 B	22-07-1999
		AU 5650296 A	29-11-1996
		CA 2220426 A	14-11-1996
		CN 1183870 A	03-06-1998
		EP 0826280 A	04-03-1998
		JP 11505084 T	11-05-1999

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

LESON, Thomas J. A.
TIEDTKE, BÜHLING, KINNE & PARTNER
GBR
Bavariaring 4
D-80336 München
ALLEMAGNE

RECEIVED
EINGEGANGEN

13. Dez. 2001

IBK - PATENT

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing
(day/month/year)

12.12.2001

Applicant's or agent's file reference
WO 24416

IMPORTANT NOTIFICATION

International application No.
PCT/EP99/06952

International filing date (day/month/year)
20/09/1999

Priority date (day/month/year)
20/09/1999

Applicant

NOKIA NETWORKS OY et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. REMINDER

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/

 European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer

Barrio Baranano, A

Tel. +49 89 2399-8621



PCT

INFO PCT

12

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference WO 24416	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP99/06952	International filing date (day/month/year) 20/09/1999	Priority date (day/month/year) 20/09/1999
International Patent Classification (IPC) or national classification and IPC H04L1/18		
Applicant NOKIA NETWORKS OY et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of 6 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 20/04/2001	Date of completion of this report 12.12.2001
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Poggio, F  Telephone No. +49 89 2399 7958

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP99/06952

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):
- Description, pages:**

1-19 as originally filed

Claims, No.:

1-21 as originally filed

Drawings, sheets:

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP99/06952

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-21
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-21
Industrial applicability (IA)	Yes:	Claims	1-21
	No:	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

R It m V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 The following documents are cited:

D1: US-A-4 841 526 (WILSON JON C ET AL) 20 June 1989 (1989-06-20)

D2: EP-A-0 695 053 (AT & T CORP) 31 January 1996 (1996-01-31)

D3: WO 98 20511 A (PACKETEER INC) 14 May 1998 (1998-05-14)

D4: US-A-4 939 731 (REED ALLYSON ET AL) 3 July 1990 (1990-07-03)

D5: WO 96 36150 A (AHOPELTO JUHA PEKKA ;NOKIA
TELECOMMUNICATIONS OY (FI); KANERVA MIK) 14 November 1996
(1996-11-14)

2 **Independent claim 1**

Document D2 (see in particular the passages cited in the International Search Report) discloses, according to the most of the features of claim 1, an error control method for a transmission channel, wherein a transmission of data units via said transmission channel is controlled in dependence on the sequence number of a preceding data unit not yet acknowledged, said error control method comprising the step of defining a transmit window based on said sequence number of said unacknowledged preceding data unit.

It would be clear to the person skilled in the art that this known error control method reduces network throughput, since a timer has periodically to send a time-out signal to trigger the transmission of a status message which may not be appropriate to network conditions.

In consulting the prior art he would come across document D1 (see in particular the passages cited in the International Search Report), which discloses an error control method comprising the steps of:

- allowing the transmission of data unit only if the sequence number of said data unit lies within said transmit window;
- estimating a transmission quality of said transmission channel; and
- changing the transmission rate of acknowledgment messages in response to

said estimated transmission quality of said transmission channel.

To a skilled person, therefore, starting from the communication system defined by document D2 and being aware of the disclosure of document D1, it would be obvious to apply the approach described in D1 to the communication system of D2 in order to improve it. He would thus arrive at a communication system corresponding to subject matter of claim 1 without the aid of any inventive activity.

The subject matter of claim 1 therefore does not involve an inventive step so that this claim does not comply with the dispositions set out in Articles 33 (1), (3) PCT.

3 Independent claim 11

Independent apparatus claim 11 discloses the error control apparatus adapted to perform the method described in independent claim 1; its features, as stated in section 2 of the present Written Opinion, are already known from document D1 and D2.

The same considerations outlined with respect to claim 1 are thus also valid for independent claim 11.

The subject-matter of independent claim 11 therefore is not inventive so that the claim does not comply with the dispositions set out in Articles 33 (1) and (3) PCT.

4 Dependent claims 2 to 10 and 12 to 21

Dependent claims 2 to 10 and 12 to 21 do not appear to contain any additional features which in combination with the features of any claim to which they refer, involve an inventive step for the following reasons: the subject-matter of said claims is either directly derivable from prior art documents D1-D5 or represent minor design details generally known in the field of data communication networks.

The subject-matter of dependent claims 2 to 10 and 12 to 21 therefore does not involve an inventive step so that these claims do not comply with the dispositions set out in Articles 33 (1) and (3) PCT.

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/EP99/06952

R Item VII

Certain defects in the international application

- a) To meet requirements of Rule 6.3 (b) PCT, the independent claims should have been properly drafted in the two-part form and should include reference signs in parentheses as required by Rule 6.2 (b) PCT.
- b) The opening part of the description should have been modified to bring it into agreement with any amended independent claims, Rule 5.1 (a) (iii) PCT.
The invention as claimed should be disclosed in such a way that the technical problem, or problems, with which it deals can be appreciated and the solution can be understood, Rule 5.1 (a) (iii) PCT.
- c) The relevant documents of the International Search Report should have been acknowledged and the state of the art disclosed therein should have been briefly discussed in the opening part of the description, Rule 5.1 (a) (ii) PCT.

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

LESON, Thomas J. A.
TIEDTKE, BÜHLING, KINNE & PARTNER
GBR
Bavariaring 4
D-80336 München
ALLEMAGNE

RECEIVED
EINGEGANGEN

- 4. Sep. 2001

IBK PATENT

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing
(day/month/year)

03.09.2001

Applicant's or agent's file reference

WO 24416

REPLY DUE

within 2 month(s) and 15 days
from the above date of mailing

International application No.

PCT/EP99/06952

International filing date (day/month/year)

20/09/1999

Priority date (day/month/year)

20/09/1999

International Patent Classification (IPC) or both national classification and IPC

H04L1/18

Applicant

NOKIA NETWORKS OY et al.

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

- I ☒ Basis of the opinion
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain document cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 20/01/2002.

From: 18.11.2001
To: 18.11.2001

Name and mailing address of the international preliminary examining authority:



European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner

Poggio, F

Formalities officer (incl. extension of time limits)

Ahrens, R



I. Basis of the opinion

1. With regard to the **elements** of the international application (Replacement *sheets which have been furnished to the receiving Office in response to an invitation under Article 14* are referred to in this opinion as "*originally filed*");

Description, pages:

1-19 as originally filed

Claims, No.:

1-21 as originally filed

Drawings, sheets:

1/4-4/4 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	
Inventive step (IS)	Claims	1-21
Industrial applicability (IA)	Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 The following documents are cited:

- D1: US-A-4 841 526 (WILSON JON C ET AL) 20 June 1989 (1989-06-20)
- D2: EP-A-0 695 053 (AT & T CORP) 31 January 1996 (1996-01-31)
- D3: WO 98 20511 A (PACKETEER INC) 14 May 1998 (1998-05-14)
- D4: US-A-4 939 731 (REED ALLYSON ET AL) 3 July 1990 (1990-07-03)
- D5: WO 96 36150 A (AHOPELTO JUHA PEKKA ;NOKIA
TELECOMMUNICATIONS OY (FI); KANERVA MIK) 14 November 1996
(1996-11-14)

2 Independent claim 1

Document D2 (see in particular the passages cited in the International Search Report) discloses, according to the most of the features of claim 1, an error control method for a transmission channel, wherein a transmission of data units via said transmission channel is controlled in dependence on the sequence number of a preceding data unit not yet acknowledged, said error control method comprising the step of defining a transmit window based on said sequence number of said unacknowledged preceding data unit.

It would be clear to the person skilled in the art that this known error control method reduces network throughput, since a timer has periodically to send a time-out signal to trigger the transmission of a status message which may not be appropriate to network conditions.

In consulting the prior art he would come across document D1 (see in particular the passages cited in the International Search Report), which discloses an error control method comprising the steps of:

- allowing the transmission of data unit only if the sequence number of said data unit lies within said transmit window;
- estimating a transmission quality of said transmission channel; and
- changing the transmission rate of acknowledgment messages in response to

said estimated transmission quality of said transmission channel.

To a skilled person, therefore, starting from the communication system defined by document D2 and being aware of the disclosure of document D1, it would be obvious to apply the approach described in D1 to the communication system of D2 in order to improve it. He would thus arrive at a communication system corresponding to subject matter of claim 1 without the aid of any inventive activity.

The subject matter of claim 1 therefore does not involve an inventive step so that this claim does not comply with the dispositions set out in Articles 33 (1), (3) PCT.

3 Independent claim 11

Independent apparatus claim 11 discloses the error control apparatus adapted to perform the method described in independent claim 1; its features, as stated in section 2 of the present Written Opinion, are already known from document D1 and D2.

The same considerations outlined with respect to claim 1 are thus also valid for independent claim 11.

The subject-matter of independent claim 11 therefore is not inventive so that the claim does not comply with the dispositions set out in Articles 33 (1) and (3) PCT.

4 Dependent claims 2 to 10 and 12 to 21

Dependent claims 2 to 10 and 12 to 21 do not appear to contain any additional features which in combination with the features of any claim to which they refer, involve an inventive step for the following reasons: the subject-matter of said claims is either directly derivable from prior art documents D1-D5 or represent minor design details generally known in the field of data communication networks.

The subject-matter of dependent claims 2 to 10 and 12 to 21 therefore does not involve an inventive step so that these claims do not comply with the dispositions set out in Articles 33 (1) and (3) PCT.

Re Item VII

Certain defects in the international application

- 1 In amending the claims to meet the raised objections, the following points should also receive attention:
 - a) To meet requirements of Rule 6.3 (b) PCT, the independent claims should be properly drafted in the two-part form and should include reference signs in parentheses as required by Rule 6.2 (b) PCT.
 - b) The opening part of the description should be modified to bring it into agreement with any amended independent claims, Rule 5.1 (a) (iii) PCT.
The invention as claimed should be disclosed in such a way that the technical problem, or problems, with which it deals can be appreciated and the solution can be understood, Rule 5.1 (a) (iii) PCT.
 - c) The relevant documents of the International Search Report should be acknowledged and the state of the art disclosed therein should be briefly discussed in the opening part of the description, Rule 5.1 (a) (ii) PCT.
 - d) Care should be taken to avoid giving rise to further objection by the inadvertent addition of subject-matter, Article 34 (2) (b) PCT.
 - e) The Applicant is requested to file amendments by way of replacement pages. He should also take into account the requirements of Rule 66.8 PCT. In particular, fair copies of the amendments should be filed in triplicate.
 - f) In order to facilitate the examination of the conformity of the amended application with the requirements of Article 34 (2) (b) PCT, the Applicant is requested to clearly identify the amendments carried out, no matter whether they concern amendments by addition, replacement or deletion, and to indicate the passages of the application as filed on which these amendments are based (see also Rule 66.8 (a) PCT).

If the Applicant regards it as appropriate these indications could be submitted in handwritten form on a copy of the relevant parts of the application as filed.

PATENT COOPERATION TREATY

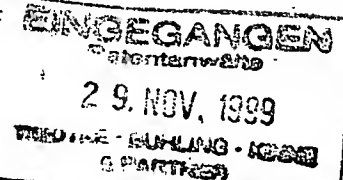
PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF RECEIPT OF
RECORD COPY

(PCT Rule 24.2(a))

PELLMANN, Hans-Bernd
Tiedtke-Bühling-Kinne et al.
Bavariaring 4
D-80336 München
ALLEMAGNE



Date of mailing (day/month/year) 23 November 1999 (23.11.99)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference WO 24416	International application No. PCT/EP99/06952

The applicant is hereby notified that the International Bureau has received the record copy of the international application as detailed below.

Name(s) of the applicant(s) and State(s) for which they are applicants:

NOKIA TELECOMMUNICATIONS OY (for all designated States except US)
RAJALA, Jussi et al (for US)

International filing date : 20 September 1999 (20.09.99)
Priority date(s) claimed :
Date of receipt of the record copy by the International Bureau : 02 November 1999 (02.11.99)
List of designated Offices :

AP : GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW
EA : AM, AZ, BY, KG, KZ, MD, RU, TJ, TM
EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE
OA : BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG
National : AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW

ATTENTION

The applicant should carefully check the data appearing in this Notification. In case of any discrepancy between these data and the indications in the international application, the applicant should immediately inform the International Bureau.

In addition, the applicant's attention is drawn to the information contained in the Annex, relating to:

- ☒ time limits for entry into the national phase
☒ confirmation of precautionary designations
☐ requirements regarding priority documents

A copy of this Notification is being sent to the receiving Office and to the International Searching Authority.

The International Bureau of WIPO 34, chemin des Colombettes 1211 GENEVA 20, Switzerland	Authorized officer: Marie-José Devillard
Facsimil N. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

INFORMATION ON TIME LIMITS FOR ENTERING THE NATIONAL PHASE

The applicant is reminded that the "national phase" must be entered before each of the designated Offices indicated in the Notification of Receipt of Record Copy (Form PCT/IB/301) by paying national fees and furnishing translations, as prescribed by the applicable national laws.

The time limit for performing these procedural acts is **20 MONTHS** from the priority date or, for those designated States which the applicant elects in a demand for international preliminary examination or in a later election, **30 MONTHS** from the priority date, provided that the election is made before the expiration of 19 months from the priority date. Some designated (or elected) Offices have fixed time limits which expire even later than 20 or 30 months from the priority date. In other Offices an extension of time or grace period, in some cases upon payment of an additional fee, is available.

In addition to these procedural acts, the applicant may also have to comply with other special requirements applicable in certain Offices. It is the applicant's responsibility to ensure that the necessary steps to enter the national phase are taken in a timely fashion. Most designated Offices do not issue reminders to applicants in connection with the entry into the national phase.

For detailed information about the procedural acts to be performed to enter the national phase before each designated Office, the applicable time limits and possible extensions of time or grace periods, and any other requirements, see the relevant Chapters of Volume II of the PCT Applicant's Guide. Information about the requirements for filing a demand for international preliminary examination is set out in Chapter IX of Volume I of the PCT Applicant's Guide.

GR and ES became bound by PCT Chapter II on 7 September 1996 and 6 September 1997, respectively, and may, therefore, be elected in a demand or a later election filed on or after 7 September 1996 and 6 September 1997, respectively, regardless of the filing date of the international application. (See second paragraph above.)

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

CONFIRMATION OF PRECAUTIONARY DESIGNATIONS

This notification lists only specific designations made under Rule 4.9(a) in the request. It is important to check that these designations are correct. Errors in designations can be corrected where precautionary designations have been made under Rule 4.9(b). The applicant is hereby reminded that any precautionary designations may be confirmed according to Rule 4.9(c) before the expiration of 15 months from the priority date. If it is not confirmed, it will automatically be regarded as withdrawn by the applicant. There will be no reminder and no invitation. Confirmation of a designation consists of the filing of a notice specifying the designated State concerned (with an indication of the kind of protection or treatment desired) and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.

REQUIREMENTS REGARDING PRIORITY DOCUMENTS

For applicants who have not yet complied with the requirements regarding priority documents, the following is recalled.

Where the priority of an earlier national, regional or international application is claimed, the applicant must submit a copy of the said earlier application, certified by the authority with which it was filed ("the priority document") to the receiving Office (which will transmit it to the International Bureau) or directly to the International Bureau, before the expiration of 16 months from the priority date, provided that any such priority document may still be submitted to the International Bureau before that date of international publication of the international application, in which case that document will be considered to have been received by the International Bureau on the last day of the 16-month time limit (Rule 17.1(a)).

Where the priority document is issued by the receiving Office, the applicant may, instead of submitting the priority document, request the receiving Office to prepare and transmit the priority document to the International Bureau. Such request must be made before the expiration of the 16-month time limit and may be subjected by the receiving Office to the payment of a fee (Rule 17.1(b)).

If the priority document concerned is not submitted to the International Bureau or if the request to the receiving Office to prepare and transmit the priority document has not been made (and the corresponding fee, if any, paid) within the applicable time limit indicated under the preceding paragraphs, any designated State may disregard the priority claim, provided that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity to furnish the priority document within a time limit which is reasonable under the circumstances.

Where several priorities are claimed, the priority date to be considered for the purposes of computing the 16-month time limit is the filing date of the earliest application whose priority is claimed.

PCT

NOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

From the INTERNATIONAL BUREAU

To:

PELLMANN, Hans-Bernd
Tiedtke-Bühling-Kinne et al.
Bavariaring 4
D-80336 München
ALLEMAGNEEINGEGANGEN
Patentanwälte

- 9. April 2001

TIEDTKE · BÜHLING · KINNE
& PARTNER (GmbH)

Date of mailing (day/month/year) 29 March 2001 (29.03.01)		IMPORTANT NOTICE	
Applicant's or agent's file reference WO 24416			
International application No. PCT/EP99/06952	International filing date (day/month/year) 20 September 1999 (20.09.99)	Priority date (day/month/year)	
Applicant NOKIA NETWORKS OY et al			

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
AU, KP, KR, US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:

AE, AL, AM, AP, AT, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EA, EE, EP, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, OA, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW
The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 29 March 2001 (29.03.01) under No. WO 01/22645

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile N. (41-22) 740.14.35

Authorized officer

J. Zahra

Telephone N. (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
 Office, PCT
 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
 in its capacity as elected Office

Date of mailing (day/month/year) 13 June 2001 (13.06.01)	
International application No. PCT/EP99/06952	Applicant's or agent's file reference WO 24416
International filing date (day/month/year) 20 September 1999 (20.09.99)	Priority date (day/month/year)
Applicant RAJALA, Jussi et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 20 April 2001 (20.04.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Pascal Piriou
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

INFORMATION CONCERNING ELECTED
OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

From the INTERNATIONAL BUREAU

T :

PELLMANN, Hans-Bernd

Tiedtke-Bühling-Kinne

Bavariaring 4

D-80336 München

ALLEMAGNE

EINGEGANGEN
Patentanwälte

20. Juni 2001

TIEDTKE · BÜHLING · KINNE
& PARTNER (GmbH)

Date of mailing (day/month/year)

13 June 2001 (13.06.01)

Applicant's or agent's file reference

WO 24416

IMPORTANT INFORMATION

International application No.

PCT/EP99/06952

International filing date (day/month/year)

20 September 1999 (20.09.99)

Priority date (day/month/year)

Applicant

NOKIA NETWORKS OY et al

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE

National : AU, BG, CA, CN, CZ, DE, IL, JP, KP, KR, MN, NO, NZ, PL, RO, RU, SE, SK, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

AP : GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW

EA : AM, AZ, BY, KG, KZ, MD, RU, TJ, TM

OA : BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG

National : AE, AL, AM, AT, AZ, BA, BB, BR, BY, CH, CU, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IN, IS, KE, KG, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MW, MX, PT, SD, SG, SI, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW

3. The applicant is reminded that he must enter the "national phase" before the expiration of 30 months from the priority date before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

The entry into the European regional phase is postponed until 31 months from the priority date for all States designated for the purposes of obtaining a European patent.

The International Bureau of WIPO

34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimil No. (41-22) 740.14.35

Authorized officer:

Pascal Piriou

Telephone No. (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

PELLMANN, Hans-Bernd
Tiedtke-Bühling-Kinne et al.
Bavariaring 4
D-80336 München
ALLEMAGNE

Date of mailing (day/month/year) 14 January 2002 (14.01.02)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference WO 24416	
International application No. PCT/EP99/06952	International filing date (day/month/year) 20 September 1999 (20.09.99)

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address NOKIA NETWORKS OY Keilalahdentie 4 FIN-02150 Espoo Finland	State of Nationality FI	State of Residence FI
	Telephone No. +358 9 1807 0	
	Facsimile No. +358 9 1807 496	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address NOKIA CORPORATION Keilalahdentie 4 FIN-02150 Espoo Finland	State of Nationality FI	State of Residence FI
	Telephone No. +358 9 1807 0	
	Facsimile No. +358 9 1807 496	
	Teleprinter No.	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer R. Raissi Telephone No.: (41-22) 338.83.38
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PCT REQUEST

WO 24416

Original (for SUBMISSION) - printed on 20.09.1999 02:27:17 PM

0	For receiving Office use only	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared using	PCT-EASY Version 2.84 (updated 01.04.1999)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	European Patent Office (EPO) (RO/EP)
0-7	Applicant's or agent's file reference	WO 24416
I	Title of invention	ERROR CONTROL METHOD AND APPARATUS
II	Applicant	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	NOKIA TELECOMMUNICATIONS OY
II-5	Address:	Keilalahdentie 4 FIN-02150 Espoo Finland
II-6	State of nationality	FI
II-7	State of residence	FI
II-8	Telephone No.	+358 9 1807 0
II-9	Facsimile No.	+358 9 1807 496
III-1	Applicant and/or inventor	
III-1-1	This person is:	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	RAJALA, Jussi
III-1-5	Address:	Huhtakoukku 31 c FIN-02340 Espoo Finland
III-1-6	State of nationality	FI
III-1-7	State of residence	FI

PCT REQUEST

WO 24416

Original (for SUBMISSION) - printed on 20.09.1999 02:27:17 PM

III-2	Applicant and/or Inventor	
III-2-1	This person is:	applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	GRÖNBERG, Petri
III-2-5	Address:	Puistopiha 2/418 FIN-02610 Espoo Finland
III-2-6	State of nationality	FI
III-2-7	State of residence	FI
IV-1	Agent or common representative; or address for correspondence The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name (LAST, First)	PELLMANN, Hans-Bernd
IV-1-2	Address:	Tiedtke-Bühling-Kinne et al. Bavariaring 4 D-80336 München Germany
IV-1-3	Telephone No.	+49 89 544690
IV-1-4	Facsimile No.	+49 89 532611
IV-1-5	e-mail	postoffice tbk-patent.com
IV-2	Additional agent(s)	additional agent(s) with same address as first named agent
IV-2-1	Name(s)	TIEDTKE, Harro; BÜHLING, Gerhard; KINNE, Reinhard; GRAMS, Klaus; LINK, Annette; VOLLNHALS, Aurel; LESON, Thomas, Johannes, Alois; TRÖSCH, Hans-Ludwig; CHIVAROV, Georgi; GRILL, Matthias; KÜHN, Alexander; OSER, Andreas; BÖCKELEN, Rainer
V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW SD SZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT

V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AL AM AT AU AZ BA BB BG BR BY CA CH&LI CN CU CZ DE DK EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT UA UG US UZ VN YU ZA ZW
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PCT REQUEST

3/4

WO 24416

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V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	Exclusion(s) from precautionary designations	NONE	
VI	Priority claim	NONE	
VII-1	International Searching Authority Chosen	European Patent Office (EPO) (ISA/EP)	
VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	19	-
VIII-3	Claims	6	-
VIII-4	Abstract	1	03_wo24416a.txt
VIII-5	Drawings	4	-
VIII-7	TOTAL	34	
VIII-8	Accompanying Items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	1	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-18	Figure of the drawings which should accompany the abstract	1	
VIII-19	Language of filing of the international application	English	
IX-1	Signature of applicant or agent		
IX-1-1	Name (LAST, First)	PELLMANN, Hans-Bernd	

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/EP
10-6	Transmittal of search copy delayed until search fee is paid	

PCT REQUEST

WO 24416

Original (for **SUBMISSION**) - printed on 20.09.1999 02:27:17 PM**FOR INTERNATIONAL BUREAU USE ONLY**

11-1	Date of receipt of the record copy by the International Bureau	
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(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
29 March 2001 (29.03.2001)

PCT

(10) International Publication Number
WO 01/22645 A1

(51) International Patent Classification⁷: H04L 1/18, 1/00, 1/16, 12/56

(21) International Application Number: PCT/EP99/06952

(22) International Filing Date:
20 September 1999 (20.09.1999)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US): NOKIA NETWORKS OY [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).

(72) Inventors; and

(75) Inventors/Applicants (for US only): RAJALA, Jussi [FI/FI]; Huhtakoukku 31 c, FIN-02340 Espoo (FI). GRÖNBERG, Petri [FI/FI]; Puistopihä 2/418, FIN-02610 Espoo (FI).

(74) Agents: PELLMANN, Hans-Bernd et al.; Tiedtke-Bühling-Kinne et al., Bavariaring 4, D-80336 München (DE).

(81) Designated States (national): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW.

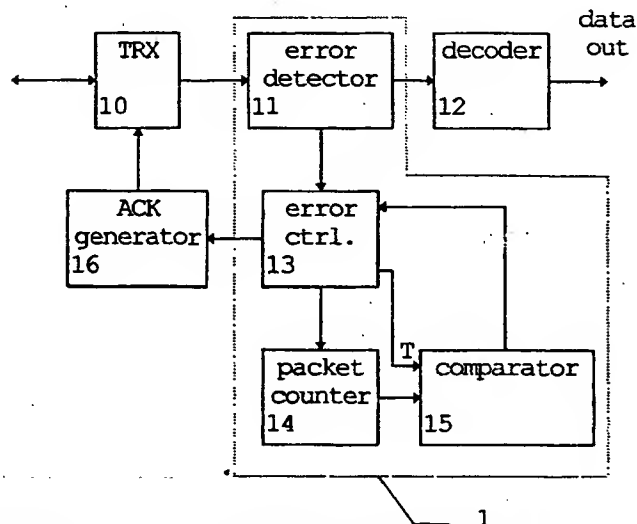
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— With international search report.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ERROR CONTROL METHOD AND APPARATUS



(57) Abstract: The invention relates to an error control method and apparatus for performing a control so as to allow a transmission of data units via a transmission channel independence on the sequence number of a preceding data unit not yet acknowledged, wherein the transmission rate of acknowledgment messages is changed in response to an estimated transmission quality of the transmission channel. Thereby, the retransmission protocol is made faster in poor channel conditions, whereas the amount of resources used for the acknowledgment message is lowered for better channel conditions. The error control may be performed at the transmitter side, wherein the transmitter commands or polls the receiver to send an acknowledgment message. The channel quality may be determined by detecting a retransmission of negatively acknowledged data unit. Alternatively, the error control can be performed at the receiver side, wherein the receiver decides when an acknowledgment shall be sent and is able to count the data units lost or erased during the transmission to thereby estimate or detect the channel quality.

WO 01/22645 A1

- 1 -

Error control method and apparatusFIELD OF THE INVENTION

5 The present invention relates to an error control method and apparatus for performing a control so as to allow a transmission of data packets via a transmission channel in dependence on the sequence number of a preceding data packet not yet acknowledged, i.e. an earlier data
10 packet which has been transmitted but not yet acknowledged as a properly received data packet. The transmission channel may be provided in a cellular network such as a GSM (Global System for Mobile communications) or a GPRS (General Packet Radio Services) network.

15

BACKGROUND OF THE INVENTION

In a digital transmission system, transmission errors occur due to noise and distortion. There are two types of
20 transmission errors: random errors and burst errors. Random errors may be caused by thermal noise. Burst errors are generated during a fade in the transmission channel. Transmission errors can be detected by adding a redundant signal (check bits) to the information signal.

25

Upon detecting a transmission error, there are two ways to control the error. One is called ARQ (Automatic Repeat Request) and uses a feedback control to request a retransmission of the corrupted data. The other called FEC
30 (Feed-forward Error Correction) uses a feed-forward control to control the errors.

In packet data networks, different transmission protocols are used to convey data via a transmission

- 2 -

channel from a source (transmitter) to a destination (receiver). Transmission protocols are typically arranged in such a manner that data to be transferred is segmented into a sequence of data packets, called Packet Data Units (PDUs) which are then individually transferred to the destination where they are finally reassembled by the transmission protocol.

Each PDU has a header and a data part. The former contains information essential for the transmission protocol, such as an element defining the destination and/or the sequence number by which the PDU can be identified, whereas the latter contains a piece of the actual data packet being transferred.

15

To achieve a reliable data transmission, the transmission protocol has to assure that all transmitted PDUs are received correctly by the receiver. For this purpose, the receiver sends acknowledgments to the transmitter which in turn retransmits the unacknowledged or negatively acknowledged PDUs according to a specified ARQ scheme. A widely used ARQ scheme is the so-called Go-Back-N method where the receiver acknowledges all the PDUs up to a certain sequence number N. In particular, the receiver sends the sequence number N up to which it has received all PDUs properly and in order. After receiving such an acknowledgment, the transmitter continues the transmission starting from the specified sequence number N. During the so-called round-trip delay, the receiver may have already transmitted PDUs with sequence numbers larger than N. Nevertheless, the transmitter continues transmission by (re)transmitting the PDUs with sequence numbers N, N+1, N+2, ..., when receiving such an acknowledgement.

- 3 -

In the so-called Selective Retransmission ARQ scheme, the receiver sends acknowledgments where the successfully received PDUs are specified based on their sequence numbers. When receiving such an acknowledgment, the transmitter has to retransmit only the lost or erased PDUs, whereby transmission resources are saved. Thus, this scheme has the highest efficiency. The Selective Retransmission ARQ scheme is commonly used together with the so-called Sliding Window method. According to this method the transmitter is allowed to transmit or retransmit only those PDUs having sequence numbers within a specified transmit window. The transmit window starts at the first PDU which has not been acknowledged and spreads over K PDUs, wherein K denotes the size of the window. The receiver has a corresponding receive window and accepts only those PDUs having sequence numbers within the receive window. The receive window starts at the first PDU which has not been received and spreads over K PDUs. It can be shown that with a window size of K the transmitted PDUs can be uniquely identified for sequence numbers ranging from 0 to $(2K - 1)$.

In the acknowledgment messages, the successfully received PDUs are specified. When the first unacknowledged PDU in the beginning of the transmit window is acknowledged the transmitter can move its transmit window forward until the next unacknowledged PDU is found. Thereby, the transmission is slid over new PDUs which can then be transmitted.

However, in case a transmitter using the Selective Retransmission ARQ scheme with the Sliding Window method is able to transmit a considerable amount of PDUs within the transmit window during a round-trip delay of the transmission channel, i.e. a delay between the transmission

- 4 -

of a PDU and the receipt of the corresponding acknowledgment message, the transmit window may be stalled during the transmission resulting in a reduced throughput. In such a case, all PDUs within the transmit window have
5 been transmitted at least once and the transmitter has to wait until the transmit window can be slid further. The probability of a stalled transmit window rises with the rate of erased PDUs within all transmitted PDUs (Packet Erasure Rate, PER).

10

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an error control method and apparatus by means of
15 which the transmission throughput can be increased in the Sliding Window method.

This object is achieved by an error control method for a transmission channel, wherein a transmission of data
20 units via the transmission channel is controlled in dependence on the sequence number of a preceding data unit not yet acknowledged, the error control method comprising the steps of:

defining a transmit window based on the sequence number
25 of the preceding data unit not yet acknowledged;

allowing the transmission of a data unit only if the sequence number of the data unit lies within the transmit window;

estimating a transmission quality of the transmission
30 channel; and

changing the transmission rate of acknowledgment messages in response to the estimated transmission quality of the transmission channel.

- 5 -

Additionally, the above object is achieved by an error control apparatus for performing a control so as to allow a transmission of data units via a transmission channel in dependence on the sequence number of a preceding data unit not yet acknowledged, the error control apparatus comprising:

detecting means for detecting a transmission quality of the transmission channel; and

control means for changing the transmission rate of acknowledgment messages in response to the transmission quality detected by the detecting means.

Accordingly, the retransmission protocol is made faster in poor channel conditions, whereas the amount of resources used for acknowledgment messages is lower for better channel conditions. Thereby, the retransmission delay and the amount of resources required for the acknowledgment messages are adapted to the channel conditions, to thereby optimize the ARQ scheme. The acknowledgment strategy for the Selective Retransmission ARQ scheme with the Sliding Window method can thus be adapted to different and possibly changing PER values and provides a good throughput without an excessive amount of transmitted acknowledgment messages. Acknowledgment messages are generated more frequently, when the PER is high, whereas the acknowledgment rate is reduced in cases of lower PER values. Thereby, transmission resources and processing power can be saved without reducing the throughput of the primary transmission.

The transmission rate of the acknowledgment messages may be changed in response to a data unit erasure or loss detected at the receiving end of the transmission channel. In this case, the number of data units which have been successfully received may be counted, the count value may

- 6 -

be increased by the predetermined value when a packet erasure or loss has been detected, and an acknowledgment message may be transmitted when the counter value exceeds a predetermined threshold value. Alternatively, instead of
5 increasing the count value by the predetermined value, the predetermined threshold value may be decreased when a data unit erasure or loss has been detected.

Thus, the receiver decides on the transmission timing
10 of acknowledgments and is able to count the data units lost or erased during the transmission.

Alternatively, the transmission rate of the acknowledgment messages may be changed in dependence on a
15 retransmission of a negatively acknowledged data unit. In this case, the number of unacknowledged data units transmitted via the transmission channel may be counted, the counter value may be increased by a predetermined value when a negatively acknowledged data unit has been
20 retransmitted, and a transmission of an acknowledgment message may be polled, when the counter value exceeds a predetermined threshold value. Alternatively, instead of increasing the count value by the predetermined value, the predetermined threshold value may be decreased when a
25 negatively acknowledged data unit has been retransmitted.

Thus, the transmitter commands or polls the receiver to send an acknowledgment message. This can be done for
instance by setting a predefined polling bit provided or
30 defined in the header of a transmitted data unit.

In the transmitter side error control as well as the receiver side error control, a simple algorithm easy to implement is thus provided.

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Preferably, the predetermined value and/or the predetermined threshold value are adjusted based on a transmission rate of the data units, a size of the transmit window and/or a round-trip delay of the transmission channel. Thereby, the error control can be optimized with respect to the characteristics of the transmission channel.

The detecting means may be arranged to detect a data unit erasure or loss at a receiving end of the transmission channel, or may be arranged to detect a negative acknowledgment message received at a transmission end of the transmission channel.

In case of the receiver side control, counting means for counting the number of data units which have been received successfully, and comparing means for comparing the count value obtained from the counting means with the predetermined threshold value may be provided, wherein the control means may be arranged to increase the count value of the counting means by a predetermined value or to decrease the predetermined threshold value, when a data unit erasure or loss has been detected by the detecting means, and to initiate a transmission of an acknowledgment message when the comparing result of the comparing means indicates that the count value has exceeded the predetermined threshold value.

In the transmitter side control, counting means for counting the number of unacknowledged data units transmitted via the transmission channel and comparing means for comparing the count value of the counting means with a predetermined threshold value may be provided, wherein the control means may be arranged to increase the

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count value by a predetermined value, or to decrease the predetermined threshold value, when a negatively acknowledged data unit is retransmitted, and to poll for a transmission of an acknowledgment message when the
5 comparing result of the comparing means indicates that the count value has exceeded the predetermined threshold value.

Preferably, the control means is arranged to adjust the predetermined value and/or the predetermined threshold
10 value based on a transmission rate of the data units, a size of the transmit window and/or a round-trip delay of the transmission channel.

15 BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be described in greater detail on the basis of a preferred embodiment with reference to the accompanying drawings, wherein

20 Fig. 1 shows a basic block diagram of an error control apparatus according to the preferred embodiment arranged at the receiving side of the transmission channel,

Fig. 2 shows a flow diagram of the receiver side error control according to the preferred embodiment of the
25 present invention,

Fig. 3 shows a basic block diagram of an error control apparatus according to the preferred embodiment arranged at the transmitting side of the transmission channel; and

30 Fig. 4 shows a flow diagram of a transmitter side error control according to the preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

5 The preferred embodiment of the present invention will now be described on the basis of an RLC (Radio Link Control) connection provided in a GPRS network.

10 An RLC connection is comprised of two peer entities. Each RLC endpoint has a receiver which receives RLC data blocks. Each RLC endpoint also has a transmitter which transmits RLC data blocks. Each endpoint's receiver has a receive window. In an RLC acknowledged mode, the receive window is defined in such a manner that the difference between the sequence number of the oldest data packet, i.e.
15 RLC data block, not received and the sequence number of the next data block expected to be received is less or equal than a predefined window size. All received data blocks which meet this criteria are valid within the receive window.

20

Furthermore, each endpoint's transmitter has a transmit window. In the RLC acknowledged mode, the transmit window is defined such that the difference between the sequence number of the oldest data block not positively acknowledged
25 and the sequence number of the next data block to be transmitted is less or equal to the predefined window size. All data blocks which meet this criteria are valid within the transmit window.

30

In the present GPRS network, one connection endpoint may be a mobile station and the other endpoint may be a network element such as a PCU (Packet Control Unit).

- 10 -

Each RLC endpoint transmitter has an associated acknowledge state array indicating the acknowledgment status of the previous RLC data blocks within the transmit window. The array is indexed relative to the oldest data block not positively acknowledged (unacknowledged data
5 block) or relative to the starting sequence number. The sequence number of the next data block to be transmitted is updated based on the content of a received packet acknowledgment message. If a received packet
10 acknowledgement message has indicated that some of the data blocks have to be retransmitted, then the RLC endpoint transmitter retransmits negatively acknowledged data blocks at first, starting from the oldest one, and then returns to the original transmission order. If the transmit window is
15 stalled, then the RLC endpoint transmitter may retransmit the unacknowledged data blocks starting from the oldest one until the window can be slid further.

In the uplink direction, a packet uplink acknowledgment
20 message is sent by the GPRS network to the mobile station in order to indicate the status of the received RLC data blocks. This message may also update the timing advance and power control parameters. In the downlink direction, a
packet downlink acknowledgment message is sent from the
25 mobile station to the network to indicate the status of downlink RLC data blocks received and to report the channel quality of the downlink channel.

Each RLC endpoint receiver has an associated sequence
30 number of the oldest data block not received. This sequence number may be set to the value 0 at the beginning of each transmission in which the RLC endpoint is the receiver. The sequence number of the oldest data block not received is set to the sequence number of the next data block expected

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to be received, if all RLC data blocks within the receive window have been received properly.

Each RLC endpoint receiver has an associated receive
5 state array indicating the receive status of previous RLC
data blocks within the receive window. The array is indexed
relative to the sequence number of the next data block
expected to be received. When an RLC data block having a
sequence number within the receive window is received, the
10 corresponding element of the receive state array is set to
the value RECEIVED. When an element falls outside the
active receive window, the corresponding element is set to
the value INVALID. Thereby, the receive window is moved
forward during the transmission.

15

According to the preferred embodiment, a strategy for
generating acknowledgment messages is implemented, wherein
the rate of transmitting acknowledgment messages is changed
on the basis of the transmission quality of the
20 transmission channel, e.g. the RLC connection. In
particular, acknowledgment messages are generated more
frequently when the PER is high, and the acknowledgment
rate is reduced when the PER is low.

25

In the following two alternative examples for
implementing the above strategy are described.

30

According to the first example, a receiver side error
control is performed, wherein the RLC endpoint receiver
decides when an acknowledgment shall be send and is able to
count the data blocks lost or erased during the
transmission. This means that the receiver has to have
knowledge of the data blocks to be received or has to be
able to detect the data blocks which have been transmitted

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to it, even if the data blocks may have been corrupted during the transmission.

Fig. 1 shows a block diagram of a receiver at an endpoint of an RLC connection. It is to be noted that only those blocks of the receiver which are essential to the present invention are shown in Fig. 1.

According to Fig. 1, the receiver comprises a transceiver (TRX) 10 for receiving data blocks transmitted via the RLC connection and for transmitting acknowledgment messages generated by an acknowledgment message generator 16. The received data blocks are supplied to an error detector 11 arranged for detecting a lost or erased data block. This may be achieved on the basis of the sequence numbers of received data blocks, the reception timing of received data blocks, the receive state array, or the like. The received data blocks are then supplied to a decoder 12 for decoding the data blocks according to a (higher level) protocol used for supplying the data to a data sink.

Furthermore, the receiver comprises a packet counter 14 which is initialized at the beginning of a transmission. An error control unit 13 controls the packet counter 14 so as to be incremented by one whenever an information indicating a successful receipt of a data block has been supplied from the error detector 11 to the error control unit 13. The control of the packet counter 14 may be performed by supplying count pulses or the like thereto. Whenever a lost or erased data block is detected by the error detector 11, a corresponding information is applied to the error control unit 13 which subsequently controls the packet counter 14 so as to be increased by $(1 + W)$, where W denotes a weighting parameter larger than 0.

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Furthermore, a comparator 15 is provided to which the count value of the packet counter 14 is supplied and which compares the count value with a predetermined threshold value T supplied from the error control unit 13. The comparison result is supplied to the error control unit 13.

According to the above arrangement, an error processing unit 1 consisting of the blocks 11, 13, 14 and 15 is provided, which detects lost or erased data blocks and which controls the acknowledgment message generator 16 so as to generate an acknowledgment message when the count value of the packet counter 14 exceeds the predetermined threshold value T. To achieve this, the error control unit 13 is connected to the acknowledgment message generator 16 in order to supply a control signal for initiating the generation of an acknowledgment message.

The parameters W and T may be adjusted separately for various systems based on their transmission rates, window sizes and round-trip delays. This may be performed by the error control unit 13 based on a corresponding external information or an initial programming of the error control unit 13.

25

In the following, the error control operation according to the first example of the preferred embodiment will be described on the basis of a flow diagram shown in Fig. 2.

At the beginning of a transmission, the packet counter 14 is initialized (S100), then the transmission is started in step S101. Thereafter, the error control unit 13 determines in step S102, whether the error detector 11 has indicated the successful receipt of a data block. If so,

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the error control unit 13 supplies a control signal to the packet counter 14 so as to increment the count value (S103). If the error detector 11 has detected a lost or erased data block, i.e. the control unit 13 determines in
5 step S102 that the data block has not been received successfully, it controls the packet counter 14 by a corresponding control signal so as to increase the count value by the value $1 + W$.

10 Thereafter, the error control unit 13 checks in step S105 whether the comparator 15 indicates that the threshold value T has been exceeded, or not. If so, the control unit 13 initiates the transmission of an acknowledgment message by the acknowledgment message generator 16 (S106) and
15 resets the counter 14 (S107). If not the control flow proceeds to step S108, where it is checked whether the transmission end has been reached or not. If the transmission is not yet finished, the control flow returns to step S102 in order to check for the successful receipt
20 of a new data block. Otherwise, the control procedure is terminated.

According to a second example of the preferred embodiment, the error control may be performed at the
25 transmitting end of the RLC connection, wherein the transmitter polls the receiver to send an acknowledgment message.

Fig. 3 shows a basic block diagram of a transmitter at
30 an endpoint of an RLC connection. It is to be noted that only those blocks of the transmitter, which are essential to the present invention are shown in Fig. 3.

- 15 -

According to Fig. 3, the transmitter comprises a transceiver (TRX) 20 arranged to transmit data blocks supplied from an encoder 22 to the RLC connection, and to receive acknowledgment messages from a receiver arranged at the other end of the RLC connection. The encoder 22 is arranged to generate RLC data packets from supplied input data, e.g. PDUs of a higher transmission protocol. The received acknowledgment messages are supplied to an error detector 21 arranged for detecting negatively acknowledged data packets to be retransmitted. The detection may be performed on the basis of the status information included in the received acknowledgment message, the acknowledge state array, or the like. The error detector 21 supplies a corresponding detection information to an error control unit 23 arranged for controlling a packet counter 24 by supplying a corresponding control information, e.g. control pulses, based on the detection result. Furthermore, the error control unit 23 is connected to the encoder 22 in order to receive an information indicating the transmission of a new, i.e. unacknowledged, data packet.

In particular, the error control unit 23 performs an error control in such a manner that the packet counter 24 is incremented by one whenever an unacknowledged new data packet is transmitted by the TRX 20. However, whenever the error detector 21 detects a negative acknowledgment message, and the negatively acknowledged data block is retransmitted, the error control unit 23 controls the packet counter 24 so as to increase the count value by $(1 + W)$. Additionally, a comparator 25 is provided to which the count value of the packet counter 24 is supplied and which compares the count value with a predetermined threshold value T supplied from the error control unit 23. The comparison result is supplied to the error control unit 23

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which controls the encoder 22 so as to poll an acknowledgment message from the receiver at the other connection end, when the count value of the packet counter 24 exceeds the given threshold value T. Furthermore, the error control unit 23 is arranged to reset the packet counter 24 after each polling operation. The polling may be performed by controlling the encoder 22 so as to set a predetermined polling bit defined in the header of a transmitted data block.

10

Thus, an error processing unit 1 comprising the blocks 21, 23, 24 and 25 is provided, which changes the transmission rate of acknowledgment messages from the receiver at the other connection end by commanding or polling the receiver based on the received acknowledgment messages.

As an alternative, the error detection function may be provided in a kind of scheduler which supplies the data blocks to the encoder 22 according to the above described selective transmission scheme. In this case, the scheduler knows whether the actual transmission is a retransmission of a negatively acknowledged data block or a transmission of a new unacknowledged data block. This information may be fed to the error control unit 23 whenever a data block is transmitted.

In the following, the error control operation according to the second example is described on the basis of a flow diagram shown in Fig. 4.

30

According to Fig. 4, the packet counter is initialized in step S200 at the beginning of a transmission. Then, the transmission is started in step S201.

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In step S202, the error control unit 23 checks whether a negatively acknowledged data packet is retransmitted, based on the information supplied from the error detector 21 and the encoder 22. If not, i.e. in case an unacknowledged data packet is transmitted, the packet counter 24 is incremented by one in step S203. Otherwise, in case of a retransmission of a negatively acknowledged data packet, the error control unit 23 controls the packet counter 24 so as to increase the count value by $(1 + W)$.

Then, in step S205, the error control unit 23 checks whether the predetermined threshold T has been exceeded by the count value. If so, the error control unit 23 controls the encoder 22 so as to poll the receiver to send an acknowledgment message (S206). Then, the error control unit 23 controls the packet counter 24 so as to reset its count value (S207).

If the threshold value T is not exceeded in step S205, the flow advances to step S208 where the transmission end is checked. If the transmission has not yet terminated, the flow returns to step S202 where the retransmission of a negatively acknowledged packet is checked again. Otherwise, the control procedure is terminated.

Also in the second example, the parameters W and T may be adjusted separately or in combination by the error control unit 23 for various systems, based on their transmission rates, window sizes and/or round-trip delays. A corresponding system information may be externally supplied to or programmed into the error control unit 23.

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As an alternative to the above described error control performed in the first and the second example, the control units 13 and 23 may be arranged to decrease the predetermined threshold value T by a predetermined amount, 5 whenever a lost or erased data packet is detected, or, respectively, whenever a negatively acknowledged data packet is retransmitted. In this case, the packet counters 14 or 24 not necessarily have to be increased by $(1 + W)$.

10 Accordingly, the number of frames transmitted between successive acknowledgment messages is made dependent on the channel quality. When the channel quality is poor, the acknowledgment messages are transmitted more frequently, whereas the transmission rate of the acknowledgment 15 messages is decreased when the channel quality is higher.

It is to be noted that the error control functions performed by the respective blocks of the error processing unit 1 depicted in Figs. 1 and 3 may as well be implemented 20 by corresponding software routines stored in a program memory and executed by respective mikroprocessors (CPUs) arranged in the transmitter and receiver.

In summary, the invention relates to an error control 25 method and apparatus for performing a control so as to allow a transmission of data units via a transmission channel independence on the sequence number of a preceding data unit not yet acknowledged, wherein the transmission rate of acknowledgment messages is changed in response to 30 an estimated transmission quality of the transmission channel. Thereby, the retransmission protocol is made faster in poor channel conditions, whereas the amount of resources used for the acknowledgment message is lowered for better channel conditions. The error control may be

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performed at the transmitter side, wherein the transmitter commands or polls the receiver to send an acknowledgment message. The channel quality may be determined by detecting a retransmission of negatively acknowledged data unit.

- 5 Alternatively, the error control can be performed at the receiver side, wherein the receiver decides when an acknowledgment shall be sent and is able to count the data units lost or erased during the transmission to thereby estimate or detect the channel quality.

10

It should be understood that the above description and the accompanying figures are only intended to illustrate the present invention. Thus, the error control method and apparatus according to the present invention may also be

15 used in other cellular or non-cellular data networks.

15

Furthermore, the estimation of the channel or transmission quality may be performed on the basis of other parameters, such as an SIR (Signal Interference Rate), an E_b/N_0 rate, or a corresponding information derived from the received

20 data units. Moreover, the data unit may be any data packet, frame, cell, octett or part of data packet (e.g. TCP data unit) which can be acknowledged. The present invention may thus vary within the scope of the attached claims.

20

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Claims

1. An error control method for a transmission channel,
wherein a transmission of data units via said transmission
5 channel is controlled in dependence on the sequence number
of a preceding data unit not yet acknowledged, said error
control method comprising the steps of:
 - a) defining a transmit window based on said sequence
number of said unacknowledged preceding data unit,
 - 10 b) allowing the transmission of a data unit only if the
sequence number of said data unit lies within said transmit
window;
 - c) estimating a transmission quality of said transmission
channel; and
 - 15 d) changing the transmission rate of acknowledgment
messages in response to said estimated transmission quality
of said transmission channel.
2. A method according to claim 1, wherein said
20 transmission rate of said acknowledgment messages is
changed in response to a data unit erasure or loss detected
at the receiving end of said transmission channel.
3. A method according to claim 2, further comprising the
25 steps of counting the number of data units which have been
successfully received; increasing the count value by a
predetermined value when a data unit erasure or loss has
been detected; and transmitting an acknowledgment message
when said count value exceeds a predetermined threshold
30 value.
4. A method according to claim 2, further comprising the
steps of counting the number of data units which have been
successfully received; transmitting said acknowledgment

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message when the count value exceeds a predetermined threshold value; and decreasing said predetermined threshold value when a data unit erasure or loss has been detected.

5

5. A method according to claim 1, wherein said transmission rate of said acknowledgment messages is changed in dependence on a retransmission of a negatively acknowledged data unit.

10

6. A method according to claim 5, further comprising the steps of counting the number of unacknowledged data units transmitted via said transmission channel; increasing the count value by a predetermined value when a negatively
15 acknowledged data unit has been retransmitted; and polling for a transmission of an acknowledgment message when said count value exceeds a predetermined threshold value.

20

7. A method according to claim 5, further comprising the steps of counting the number of unacknowledged data units transmitted via said transmission channel; polling for a transmission of an acknowledgment message when the count value exceeds a predetermined threshold value; and decreasing said predetermined threshold value when a
25 negatively acknowledged data unit has been retransmitted.

30

8. A method according to claim 3 or 6, wherein said predetermined value is adjusted on the basis of a transmission rate of said data units, a size of said transmit window and/or a round-trip delay of said transmission channel.

9. A method according to any one of claims 3 to 8, wherein said predetermined threshold value is adjusted on

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the basis of a transmission rate of said data units, a size of said transmit window and/or a round-trip delay of said transmission channel.

- 5 10. A method according to any one of the preceding claims, wherein said transmission channel is an RLC connection for transmitting RLC data blocks in an uplink or downlink direction of a GPRS network.
- 10 11. An error control apparatus for performing a control so as to allow a transmission of data units via a transmission channel in dependence on the sequence number of a preceding data unit not yet acknowledged, said error control apparatus comprising:
- 15 a) detecting means (11; 21) for detecting a transmission quality of said transmission channel; and
- b) control means (13; 23) for changing the transmission rate of acknowledgment messages in response to the transmission quality detected by said detecting means.
- 20 12. An apparatus according to claim 11, wherein said detecting means (11) is arranged to detect a data unit erasure or loss at a receiving end of said transmission channel.
- 25 13. An apparatus according to claim 11, further comprising counting means (14) for counting the number of data units which have been received successfully, and comparing means (15) for comparing the count value obtained from said
- 30 counting means (14) with a predetermined threshold value, wherein said control means (13) is arranged to increase the count value of said counting means (14) by a predetermined value when a data unit erasure or loss has been detected by

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said detecting means (11) and to initiate a transmission of an acknowledgment message when the comparing result of said comparing means (15) indicates that the count value has exceeded said predetermined threshold value.

5

14. An apparatus according to claim 12, further comprising counting means (14) for counting the number of data units which have been received successfully, and comparing means (15) for comparing the count value obtained from said counting means (14) with a predetermined threshold value, wherein said control means (13) is arranged to decrease said predetermined threshold value when a data unit erasure or loss has been detected by said detecting means (11) and to initiate a transmission of an acknowledgment message when the comparing result of said comparing means (15) indicates that the count value has exceeded said predetermined threshold value.

15. An apparatus according to claim 11, wherein said detecting means (21) is arranged to detect a negative acknowledgment message received at a transmission end of said transmission channel.

16. An apparatus according to claim 15, further comprising counting means (24) for counting the number of unacknowledged data units transmitted via said transmission channel; and comparing means (25) for comparing the count value of said counting means (24) with a predetermined threshold value, wherein said control means (23) is arranged to increase the count value by a predetermined value when a negatively acknowledged data unit is retransmitted, and to poll for a transmission of an acknowledgment message when the comparing result of said

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comparing means (25) indicates that the count value has exceeded said predetermined threshold value.

17. An apparatus according to claim 15, further comprising
5 counting means (24) for counting the number of
unacknowledged data units transmitted via said transmission
channel; and comparing means (25) for comparing the count
value of said counting means (24) with a predetermined
threshold value, wherein said control means (23) is
10 arranged to decrease said predetermined threshold value
when a negative acknowledgment message has been detected by
said detecting means (21), and to poll for a transmission
of an acknowledgment message when the comparing result of
said comparing means (25) indicates that the count value
15 has exceeded said predetermined threshold value.

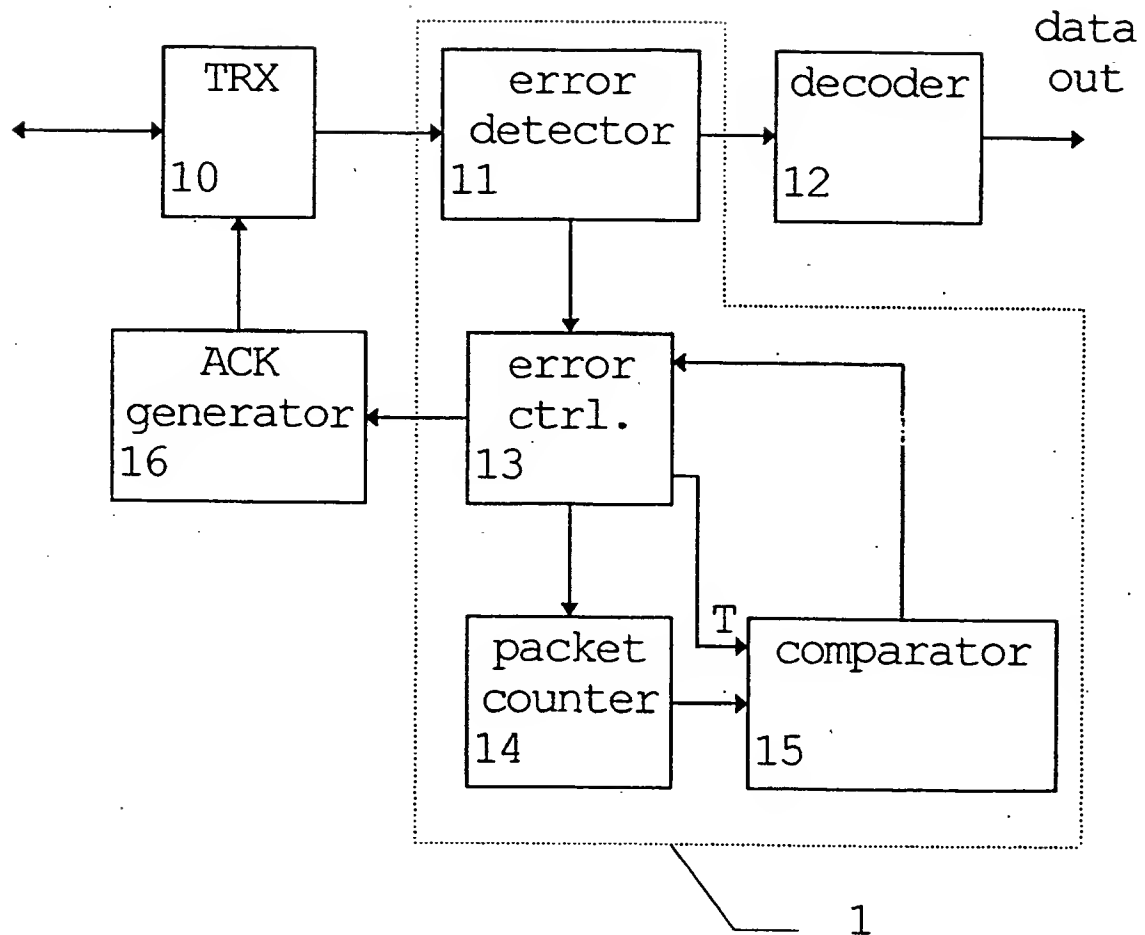
18. A apparatus according to claim 13 or 16, wherein said
control means (13; 23) is arranged to adjust said
predetermined value based on a transmission rate of said
20 data units, a size of said transmit window and/or a round-
trip delay of said transmission channel.

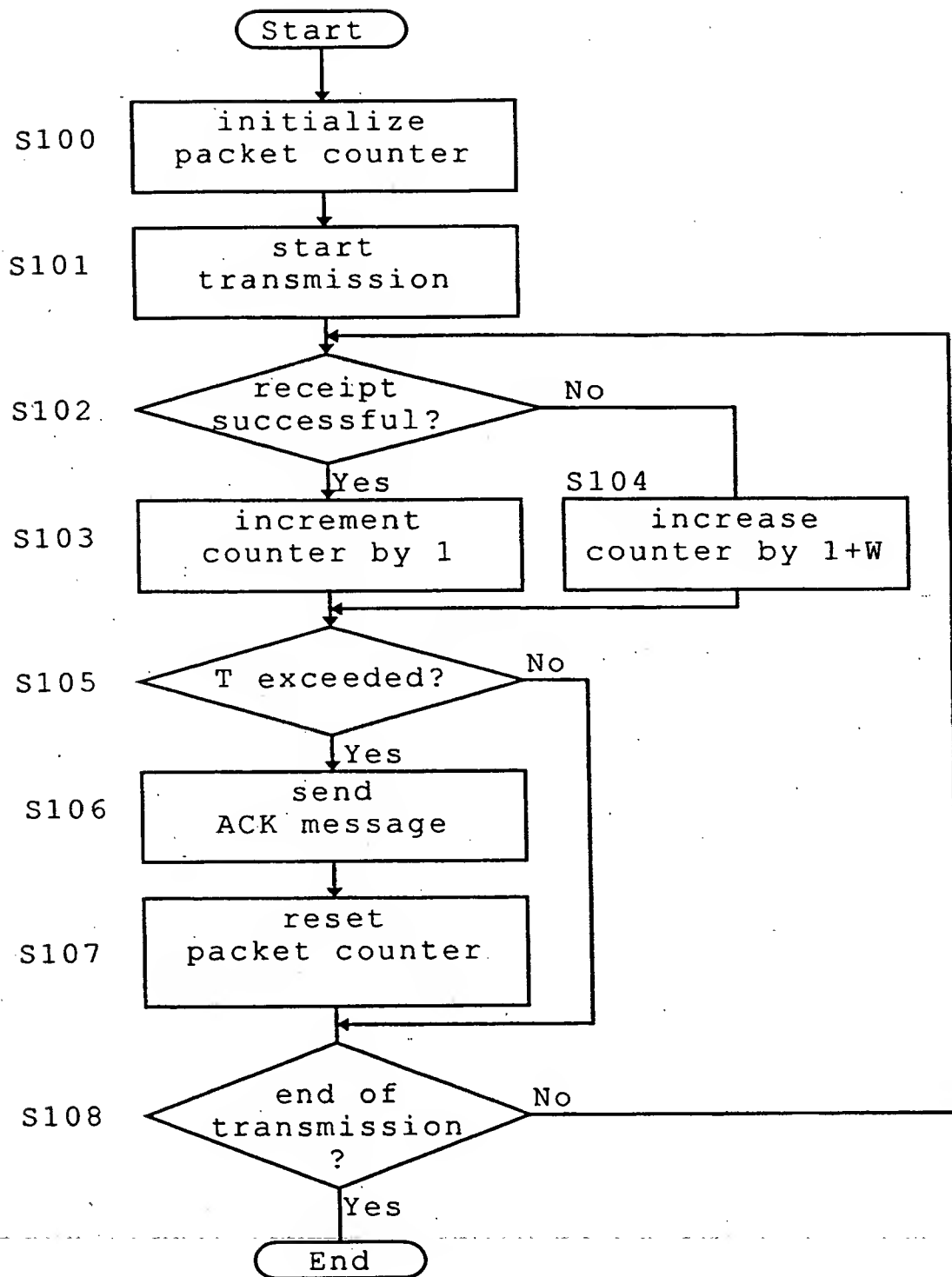
19. An apparatus according to any one of claims 13 to 18,
wherein said control means (13; 23) is arranged to adjust
25 said predetermined threshold value based on a transmission
rate of said data units, a size of said transmit window
and/or a round trip delay of said transmission channel.

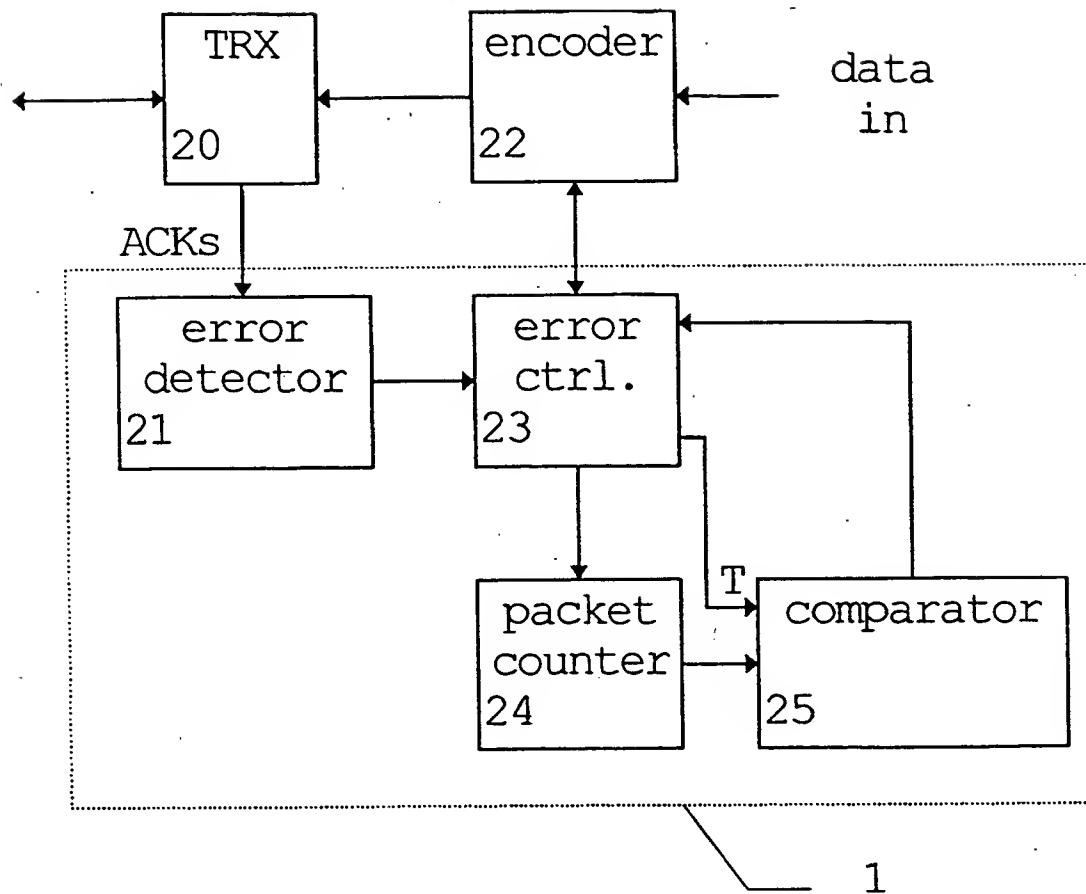
20. An apparatus according to claim 16 or 27, wherein said
30 control means (23) is arranged to perform a control such
that a polling bit is set in the header of a data unit to
be transmitted.

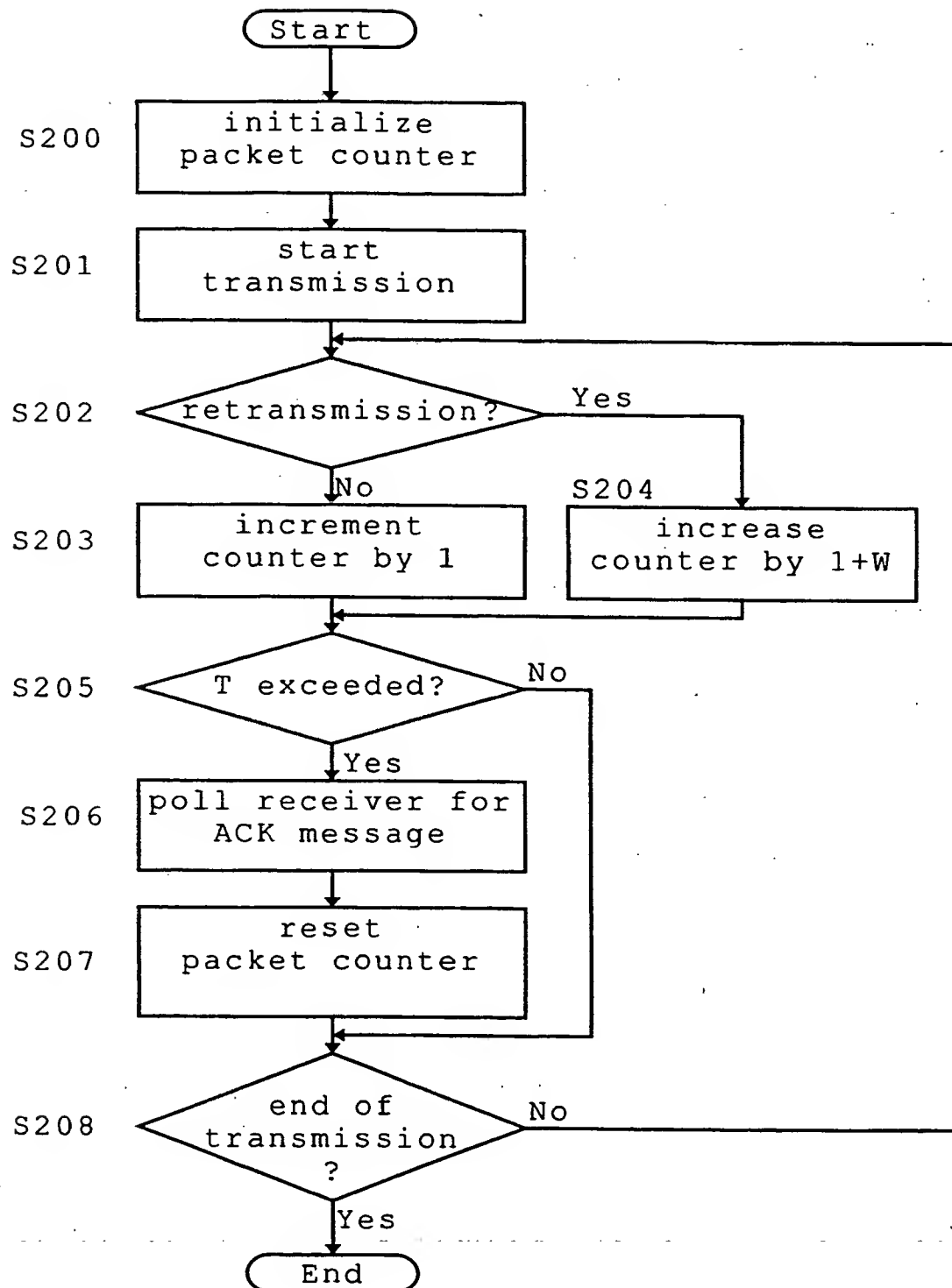
- 25 -

21. An apparatus according to any one of claims 11 to 20, wherein said error control apparatus is arranged in a mobile station and/or a network element of a GPRS network.

**Fig. 1**

**Fig. 2**

**Fig. 3**

**Fig. 4**